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INTRODUCTION

From January, 1990 through September, 1995, Cleveland State University (CSU) and Lewis Research Center (LeRC) participated in a research cooperative agreement numbered NCC3-163. Extensive study and experimentation were done by CSU on research technologies, methods, and techniques employed by the Space Station Freedom (SSF) project and, later, the Space Experiments Division (SED). In spite of many problems occasioned by the virtual cancellation of Space Station Freedom at LeRC, and organizational and financial problems at LeRC, CSU was able to do valuable work in the study and improvement of research operating methods there.

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FACILITY DOCUMENTATION

It was determined that no easily usable central source of information existed on what Space Station Freedom facilities were available for study, so CSU's first task was to document the existing Space Station facilities, both in text and photographs. This improved knowledge throughout the Space Station Freedom infrastructure of what was available and streamlined the efficient use of SSF facilities, as well as affording CSU the opportunity to screen candidate facilities for its work.

PMAD TEST BED

The Power Management And Distribution (PMAD) test bed was chosen as the first area of in-depth study for CSU as an intermediate sized facility in need of the application of modern methods of organization of control and data acquisition. This is an extensive facility for the testing of SSF power components, networks, and systems. It was determined that it had been built up as needed but had reached the point where the control and data system needed to be integrated as a macro system for speed and efficiency, rather than an amalgamation of smaller units. LeRC contracted with an independent contractor for 4000 lines of network communications code written in C to be used for communication between central control consoles and the data acquisition and control (DAC) units in the test bed. LeRC gave final acceptance of the work before it found that the software did not function properly and could not be used in its present state. Documentation was very poor making debugging extremely difficult and the contractor could not be found to remedy the problems. CSU deciphered, analyzed, debugged and expanded the software at a huge savings of time and money to LeRC.

CSU then wrote driver software as an interface between this network driver and two IBM compatible central dispatch computers, to handle communications of control commands and data between the central control system and the five DAC units then resident in the PMAD test bed. Separate software was then written for each of the five DAC units for control and acquisition of data and communication with the central dispatch computers.

Before CSU's analysis and experimentation with solutions, the PMAD test bed was able to

take all data at a maximum rate of once every four seconds. After CSU's efforts, all data could be taken each one quarter of a second; a sixteen-fold improvement in speed which was vital to the work being done by LeRC.

This test bed added a large vacuum tank for testing movable power fixtures, such as joints, which would carry power. CSU developed a user interface for this small facility as an easy, modern way for operators to use the system. The interface involved on-screen schematics of the system with point-and-click operation of valves, pumps, etc. instead of old-fashioned panels of labeled buttons. This was found to be quite useful and users were very happy with the system.

After this, CSU continued to support the software and systems it had created until such responsibilities could be shifted to LeRC personnel.

POWER SYSTEMS FACILITY CENTRAL DATA SYSTEM

Also, during this period, the usefulness of a centralized data system for use by all SSF projects was explored. The original plan was to install a high capacity data system in a central location for the use of any SSF project in the Power Systems Facility (PSF) building. Fiber optic links were to be installed to the Research Analysis Center building and the Engineering Support Center in the SPF. Because of money restrictions, it was decided that a phase I data system would be installed for initial study of the idea, to be expanded later if the concept seemed to work.

This data and control system was specified, installed and programmed by CSU. Its first use was on the Energy Storage System (ESS) nickel-hydrogen battery test which cycled prototype Space Station batteries for several thousand simulated orbits. CSU was able to demonstrate the usefulness of a centrally located, multiuser data system by getting the test DAC system, including two software PID control loops, up and running in a few weeks.

Shortly after this the Space Station Freedom lost a great deal of funding from Congress and LeRC lost almost all work, money, and responsibility connected with it. So, this central data system concept was no longer needed or supported by LeRC.

SPACE POWER FACILITY

At Plum Brook Station, near Sandusky, LeRC operates the Space Power Facility (SPF), which is the largest vacuum chamber in the world. It was built in the 1950's and its control and data systems had never been upgraded. SPF was chosen as another area of in-depth study for CSU because it is a large-sized facility in need of the application of modern methods of control and data acquisition. To replace the old relay logic and control panels, a Modicon Programmable Logic Controller was installed and a network of control and data computers was installed throughout the facility. CSU developed the data acquisition and control software and man-machine interfaces necessary to operate this facility interacting with workers at the site to experimentally develop the most user-friendly software possible, based on the needs and preferences of the actual users.

The effort was highly successful, in that CSU participated in several major tests at the facility

and even "old guard" users who had been cynical about modernization were impressed with the ease of use and the ability to change logic and functionality quickly without rewiring or mechanical alterations.

THERMAL TEST FACILITY

The Thermal Test Facility (TTF) owned by the Space Experiments Division (SED) at LeRC was a small thermal cycling chamber used to test parts and systems to be used in experiments on the Space Shuttle and, eventually, the Space Station. CSU chose this facility to investigate because it is not used by any one user or dedicated to any one project. Therefore, ease of use and a short user learning curve are of paramount importance. An extensive survey of all known past and future users was done, both by written questionnaire and by personal interviews. The results of the study showed that the chamber was being used full time for smaller jobs, but tests with larger hardware or greater requirements were being contracted out at great cost in efficiency, red tape, time, etc.

It was determined that a much larger chamber should be procured and collocated with the smaller chamber in a bigger, more ergonomically viable area. Also, the survey showed what data acquisition and control capabilities were required. After the installation of the chambers in the new location, CSU developed control, data acquisition and user interface software interacting with numerous users during the design process. Unlike the previously studied facilities, this installation required extensive help screens, easy-to-use user screens, and an extensive online user's manual.

The result was that users were able to teach themselves to use the facility. None ever called CSU personnel for help after the facility was "opened for business", even though phone and beeper numbers were posted at both chambers. And because there was no need for a formal relationship with an outside contractor, work was accomplished more quickly, easily, and efficiently.

CONCLUSION

This cooperative agreement came to a successful conclusion on September 30, 1995. NASA guidelines (as found in the Research Grant Handbook - NHB 5800.1C) state that one important purpose of a cooperative agreement is "attempting to determine and exploit the potential of scientific discoveries or improvements in technology, materials, processes, methods, devices, or techniques and advance the state of the art". CSU and its NASA technical monitors feel that this occurred to a great extent and on many levels as a result of this cooperative agreement.